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(54) Final production and testing of radio units

(57) A method for final production and testing of radio units involves initial assembly (2) and use of a conveyor container having a code which is correlated with a model code (3, 4). One of a set of six screen rooms is automatically identified as being relevant by a production controller and a conveying arrangement conveys the relevant container to the screen room. There is complete radio isolation in each screen room except when the door has been pulled open to break a seal and slide away from the opening. RF transmission tests are carried out in the screen room. However, each unit is tested in sequence for far-field effects at a final inspection station outside of the screen rooms. There is automatic blister packing in such a manner as to provide protection for switches of the radio units.

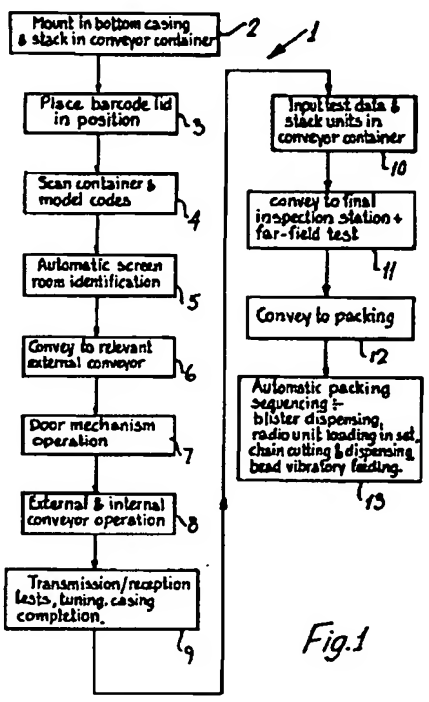

Fig.1

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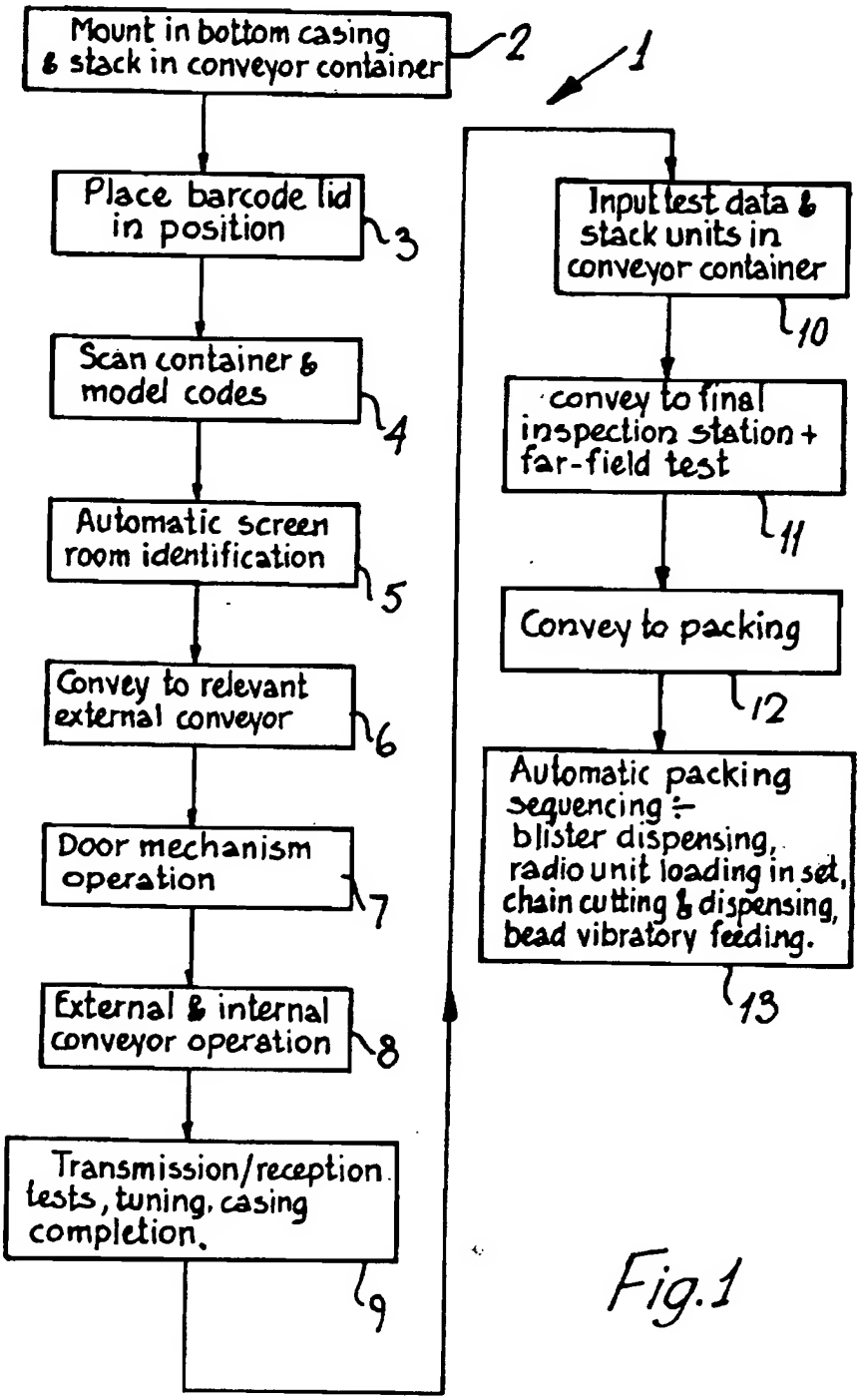
Mount in bottom casing & stack in conveyor container
2
1
Place barcode lid in position
3
Scan container & model codes
4
Automatic screen room identification
5
Convey to relevant external conveyor
6
Door mechanism operation
7
External & internal conveyor operation
8
Transmission/reception tests, tuning, casing completion.
9
Input test data & stack units in conveyor container
10
convey to final inspection station + far-field test
11
Convey to packing
12
Automatic packing sequencing :- blister dispensing, radio unit loading in set, chain cutting & dispensing, bead vibratory feeding.
13

Fig.1

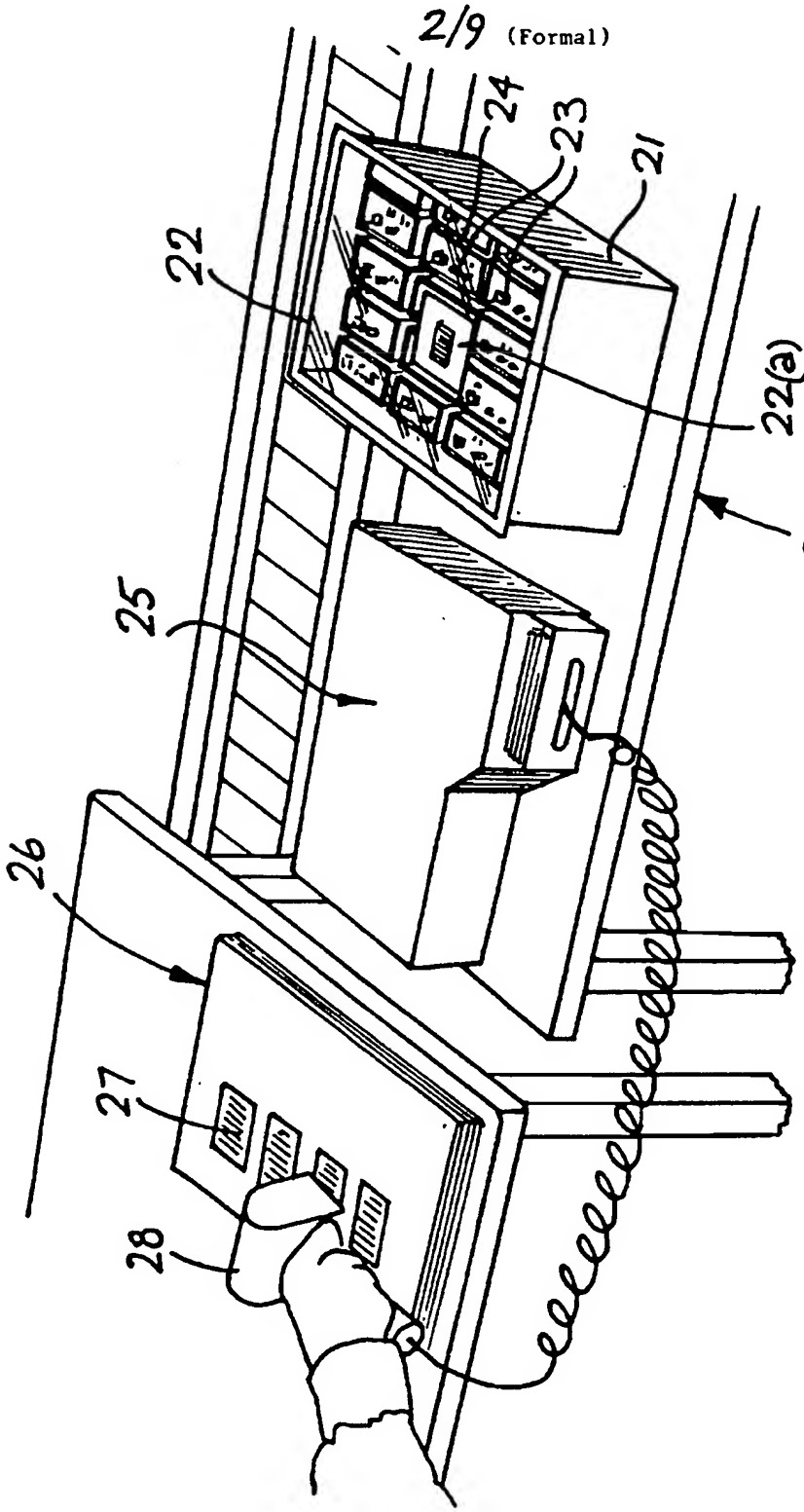

Fig. 2

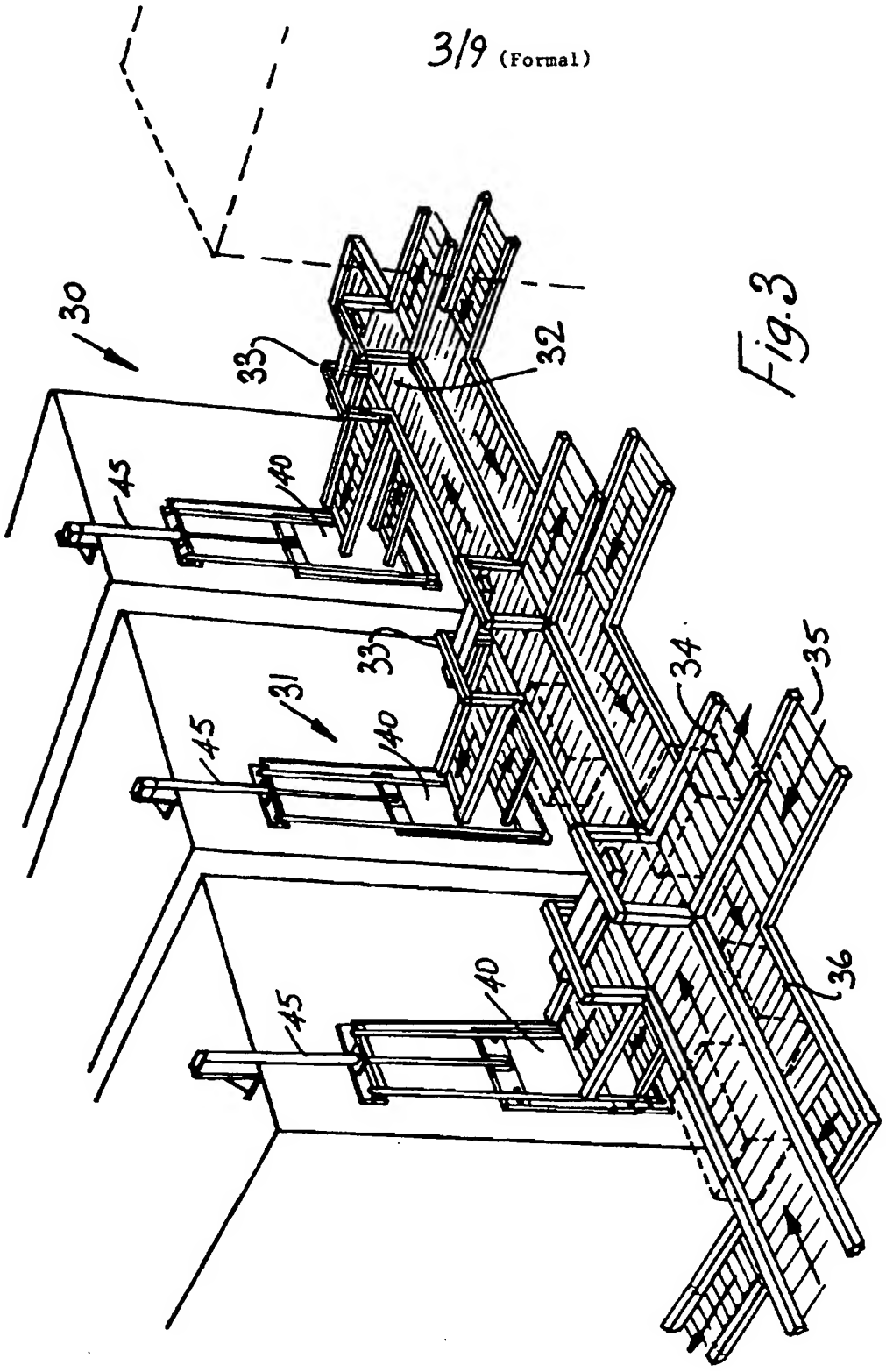

Fig. 3

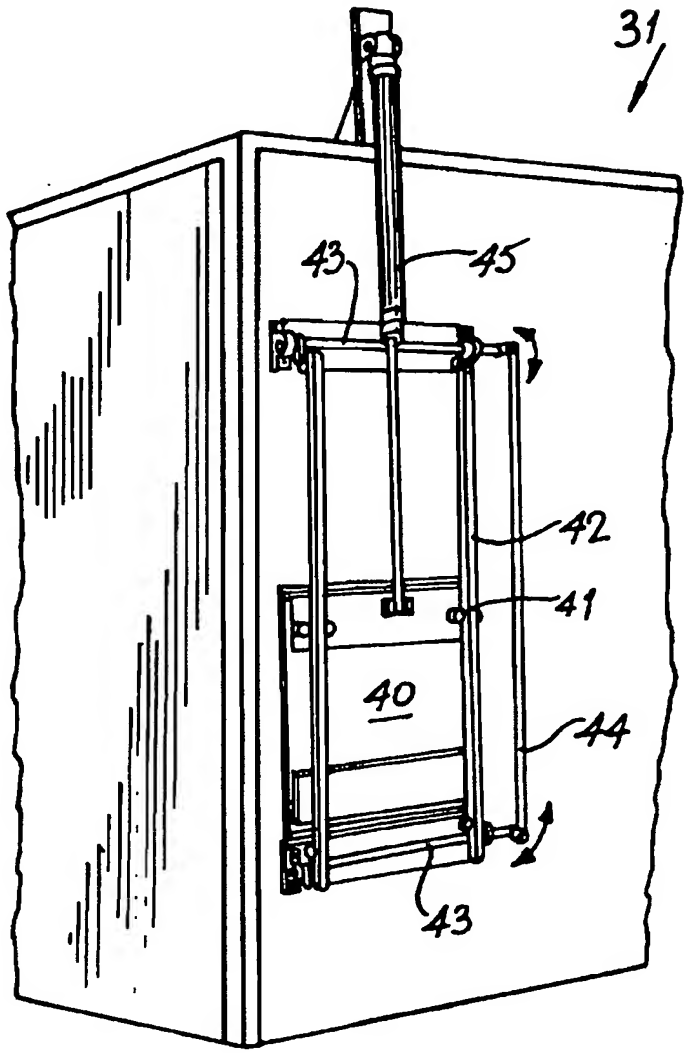

Fig.4

5/9 (Formal)

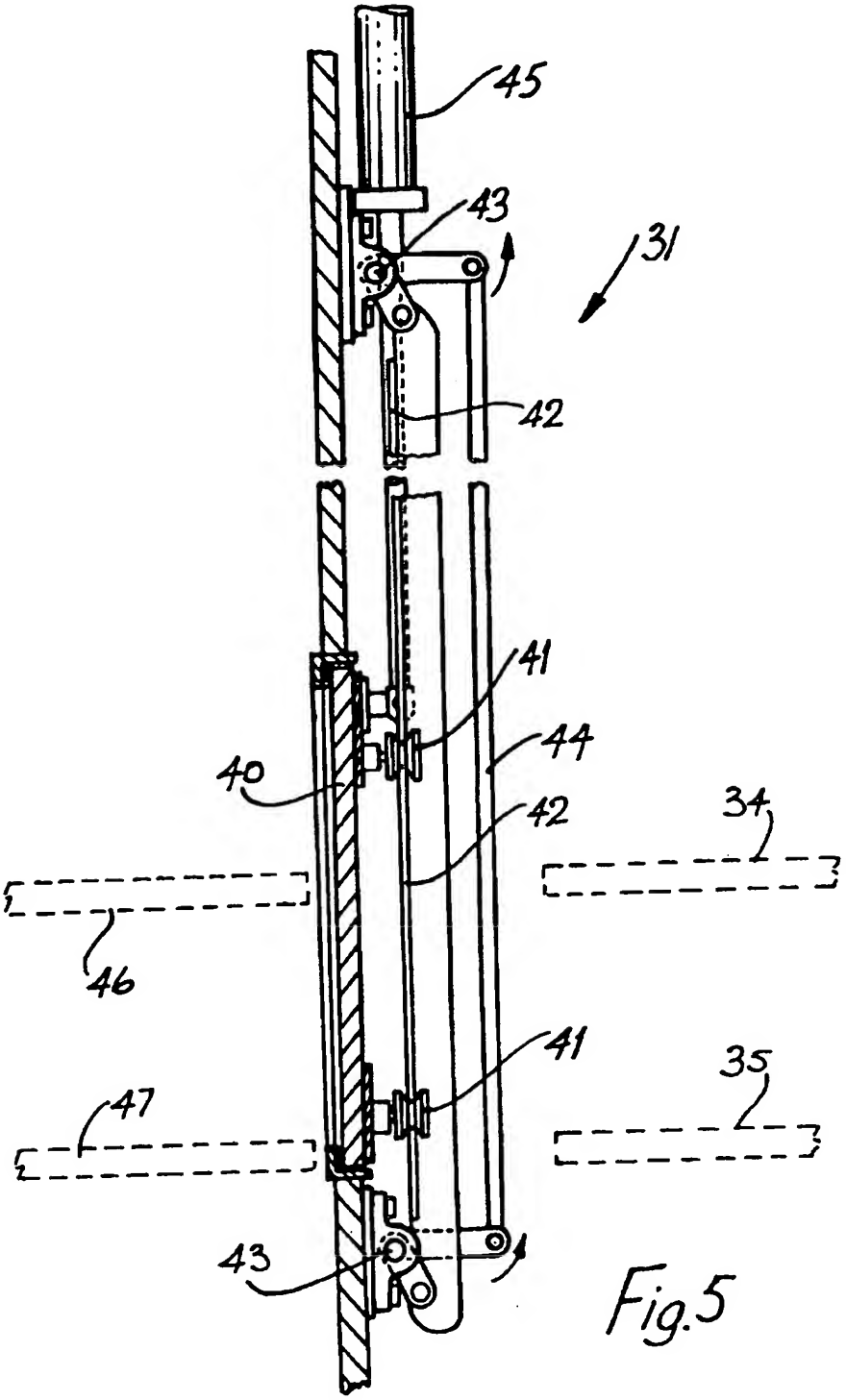

Fig. 5

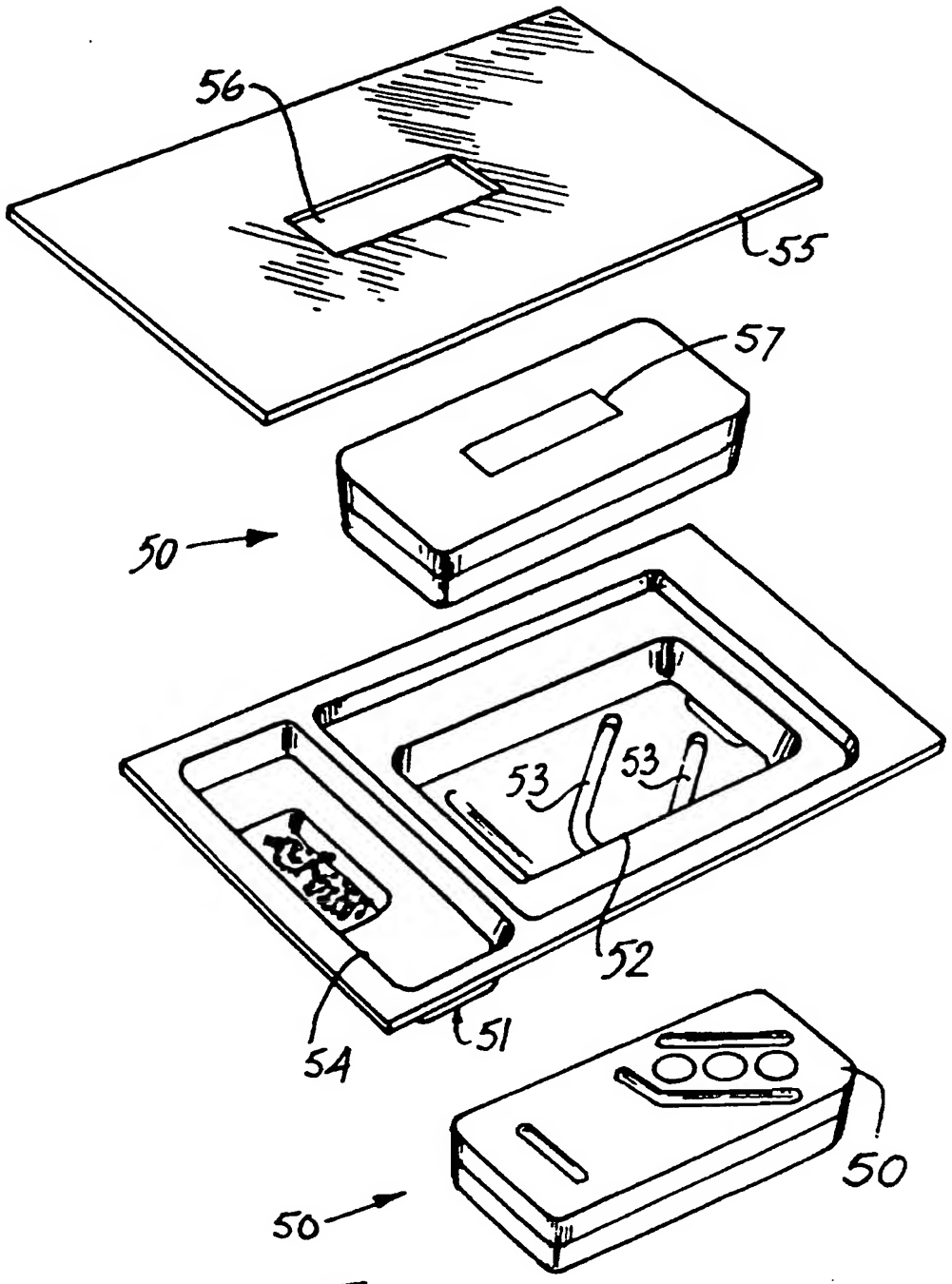

Fig.6

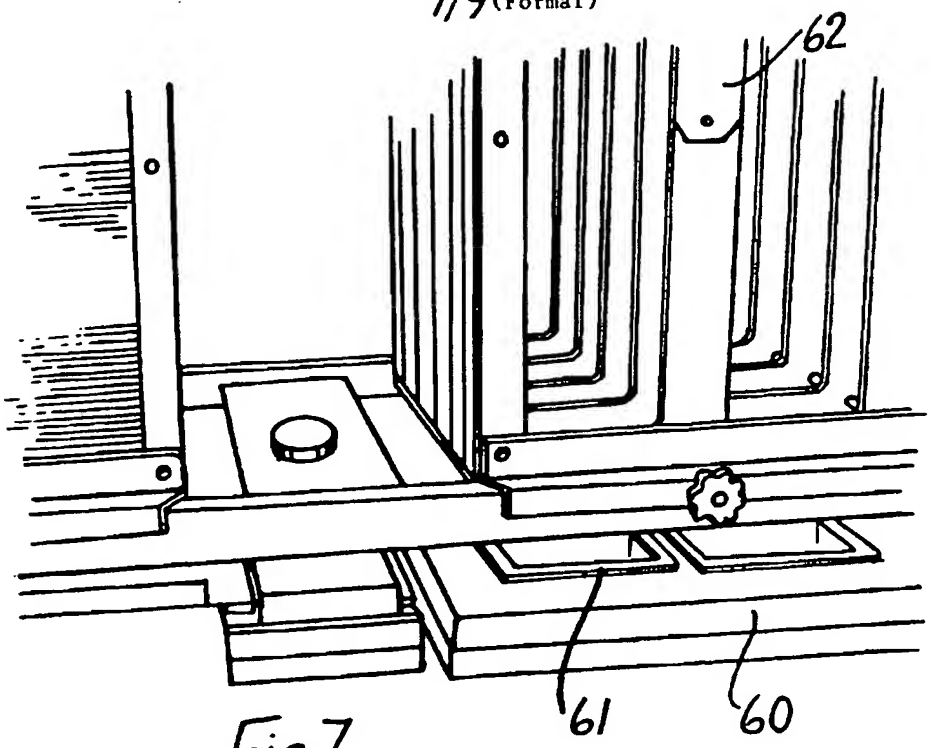

Fig. 7

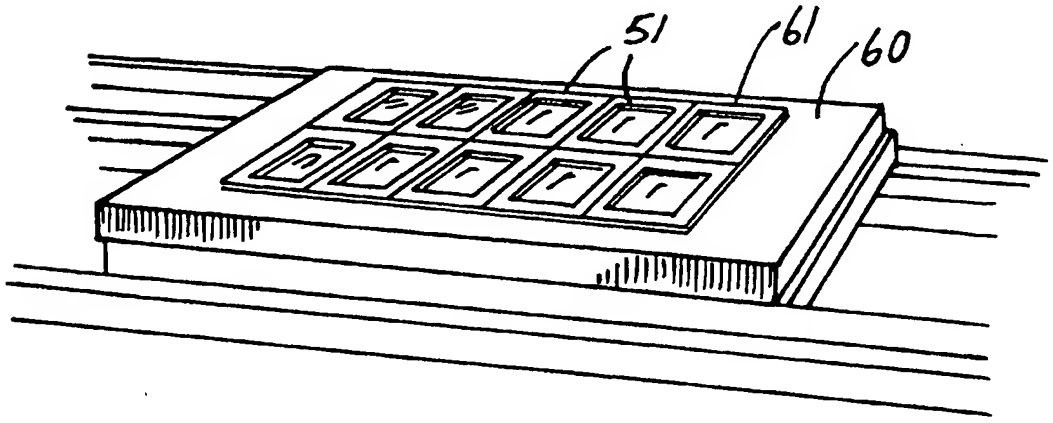

Fig. 8

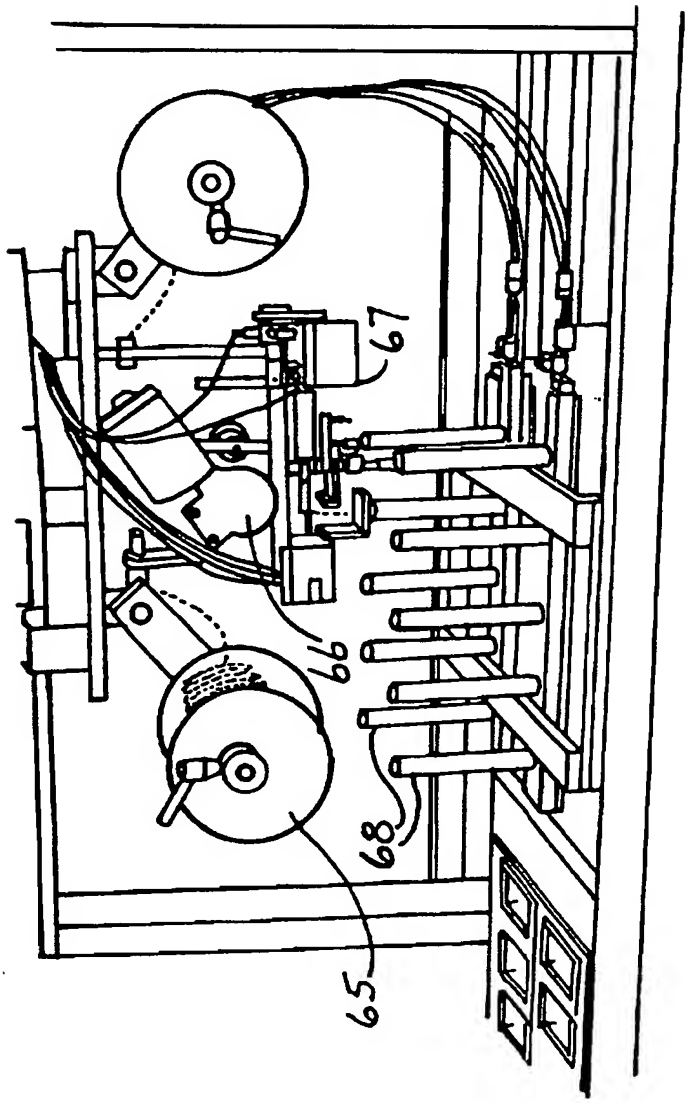

Fig. 9

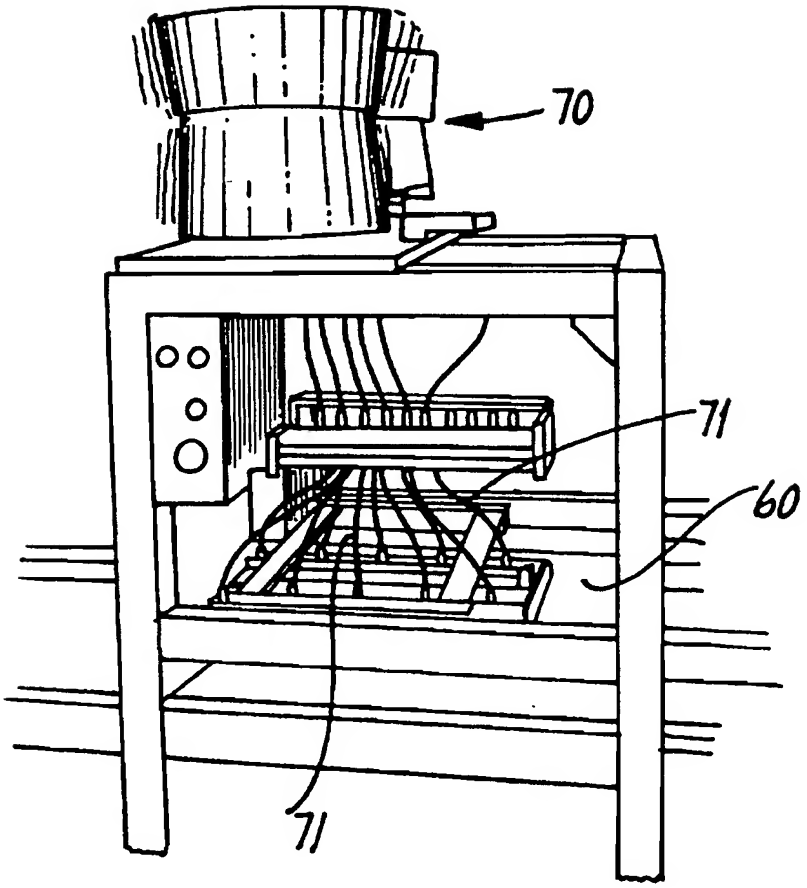

Fig. 10

"Final Production and Testing of Radio Units"

The invention relates to the final production and testing of radio units, and more particularly relatively small hand-held radio units such as remote door openers which transmit radio signals but also may receive radio signals for coding.

It is well known that testing and quality control generally for such units is an extremely important aspect of the production operation. While each individual unit has a relatively low monetary value, if it does not operate correctly, then it can cause considerable inconvenience for the user and damage the producer's reputation. In the past, conventional in-circuit testing has been carried out while the circuits of the units are integrated on a larger electronic circuit panel. Final tests are generally of a very limited nature to maintain low production costs. Such testing arrangements are not very comprehensive and, further it is quite possible that faults may arise due to incorrect handling after an in-circuit test has been carried out. For example, it is quite easy for an operator to inadvertently change the tuning setting on a radio circuit when assembling the circuit into a plastics casing. While this may appear to be a minor fault, it can cause a large amount of inconvenience for the end user. Indeed such a minor fault can result in a very large amount of expense for the producer in having a technician rectify the faults.

It is known to use screening arrangements to help improve effectiveness of testing of radio units and such arrangements are described in European Patent Specification No. EP-A2-0,339,822 (Marconi) and PCT Patent Specification No. WO 81/00915 (ACR). In both of these specifications, there is an individual hood for a

particular piece of apparatus. While such arrangements may be suitable in some circumstances, for high-volume production of relatively small, low-cost radio units this is generally not practical.

Another important aspect of production of radio units in a high volume situation is to ensure that there is effective monitoring of the various model types to ensure that they do not become mixed. Because radio units may often be sold as sets, any mixing of the units may cause considerable disruption.

The invention is directed towards providing a final production and testing method to overcome these problems.

According to the invention, there is provided a final production and testing method for hand-held radio units, the method comprising the steps of :-

separating radio unit circuits from assembled and soldered circuit panels;

placing each individual circuit in a bottom casing half and stacking partially-assembled units in a conveyor container and subsequently placing a lid over the container, the lid have a code affixed thereto;

conveying the container to an inspection station at which the bar code is automatically detected and the detected codes being automatically uploaded to a production controller of a model code, the production controller automatically correlating the container code with the model code;

the production controller automatically identifying a relevant screen room to be used for testing the units within the container according to pre-stored RF isolation plans;

conveying the container by use of longitudinal and transverse in-feed conveyors to the selected screen room, the production controller directing opening of a door adjacent the transverse in-feed conveyor, the production controller operating the transverse in-feed conveyor and also an internal conveyor within the screen room to convey the container across a gap between the transverse and internal conveyors so that it is conveyed to a testing station within the screen room;

at said testing station, carrying out RF transmission and reception tests and circuit adjustments and subsequently completing assembly of the radio unit by applying the remainder of the casing and any other units such as model labels;

the production controller directing conveying of units on return conveyors out of the screen room and to a final inspection station at which each unit is sequentially inspected; and

conveying the finally inspected units to a packing station at which automatic blister packing takes place so that the unit front is visible through a transparent blister, said blister having projections corresponding to grooves on the unit front casing half adjacent to the switches to provide protection for the switches when the units are stacked.

In one embodiment, far-field range test is carried out at the final inspection station in communication with a receiver and a transmitter located at least 50 metres away.

Preferably, the lid of the container is transparent and includes a permanently-affixed label having a bar code, said bar code being automatically identified by overhead bar code scanners mounted at different stages of the conveyors.

In another embodiment, the door of the screen room is opened by an initial outward movement of a door panel, followed by a sliding movement of the door panel away from the door opening. Preferably, the door panel is pulled outwardly by engagement of a set of wheels on a rail which is driven to move outwardly, the door panel subsequently sliding on said rail to provide the opening.

In a further embodiment, the controller controls the doors so that only one door of all of the screen rooms is open at any one time.

In another embodiment, packing is carried out by mounting a plurality of blisters within a support plate having corresponding apertures for reception of the blisters and moving said plate to a series of workstations at which the apertures are in registry with dispensing devices.

Preferably, the step of packing involves sub-steps of automatically cutting lengths of chain and dispensing individual lengths of chain into tubes for delivery of the chain lengths to particular compartments within the blisters mounted in the plate. In this latter embodiment, the packing machine preferably includes a vibratory feeder

for supply of small components to individual compartments within blisters mounted in the plate.

The invention will be more clearly understood from the following description of some embodiments thereof, given by way of example only with reference to the accompanying drawings, in which :-

Fig. 1 is a flow chart illustrating a final production and testing method of the invention;

Fig. 2 is a perspective view showing the manner in which model and container code data is captured;

Fig. 3 is a diagrammatic perspective view showing conveyor and screen room layouts;

Fig. 4 is a perspective view showing a door of a screen room;

Fig. 5 is a diagrammatic cross-sectional view showing operation of a screen room door in more detail;

Fig. 6 is an exploded perspective view showing the manner in which a radio unit is packed; and

Figs. 7 to 10 inclusive are diagrams showing sequential automatic packing steps for the radio unit.

Referring to the drawings, and initially to Fig. 1, there is shown a method 1 for the final production and testing of radio units. The radio units are hand-held units such as transmitters for door opening, or receivers for mounting at various positions in a building to receive signals relating to operation of various motors. Because the units are quite small, the circuits are assembled and

soldered as part of an integral panel having 8 or 10 individual circuits. The individual circuits are broken off after in-circuit testing and, depending on the model or type of circuit, each individual circuit is mounted in the bottom half of a moulded plastics casing. As indicated by step 2, a set of partially complete units comprising a circuit mounted in a bottom casing half are stacked into a conveyor container which is of elongate shape. Such a container is shown in Fig. 2 and is indicated by the numeral 21. Circuits 23 and the bottom casing halves 24 are also shown in Fig. 2. A very simple but important step 3 is then carried out whereby a transparent lid 22 is placed over the units in the container 21, the lid having a permanently-adhered label 22(a) with a relatively large bar code printed on it. This lid is randomly selected, but once it has been placed in position, the code indicated by the bar code on the lid is associated with that container of radio units.

The container 21 is then conveyed on a conveyor 20 to the station shown in Fig. 2 at which in step 4 an operator scans the bar code on the lid and also scans a model number bar code 27 from a catalogue 26 of bar codes. Various data is also inputted, including the quantity and any other relevant data required. These steps are carried out by a bar code controller 25 connected to a hand-held scanner 26 which reads the model bar codes 27 from the catalogue 26. A production controller is connected to the bar code controller 25 and this is programmed to automatically co-relate the container code with the model code and any other inputted data. An important aspect of the method is that in step 5 the production controller automatically identifies a screen room to be used in testing of the units in the container 21.

As shown in Fig. 3, there is a conveyor system for conveying the container 21 to one of six screen rooms 30. Each screen room 30 has an automatically operated door 31. The conveyor system comprises an in-feed longitudinal conveyor 32 above which there are vertically mounted photocells 33 at regular intervals for reading the bar codes 22(a) on the lids 22 of the containers 21 passing underneath. There is an external in-feed transverse conveyor 34 extending from the longitudinal conveyor 32 and terminating just short of each door 31. A return transverse conveyor 35 extends between each door 31 and a lower longitudinal return conveyor 36.

In step 6, the container 21 is conveyed to the relevant external transverse conveyor 35. This is achieved by the production controller automatically correlating the container with a particular screen room 30. This selection is made on the basis of assigning each screen room to a particular model to ensure that there is maximum efficiency in testing of the units as only units of one particular type may be tested in any one screen room at any one time. Indeed, the arrangement of screen rooms allows a six-fold parallel testing procedure to provide a very high degree of efficiency. There is repeated identification of the container code by use of the photocells 33 over the outfeed longitudinal conveyor 32. A side push rod (not shown) automatically pushes the container into the relevant outfeed external transverse conveyor 34. The production controller then automatically operates the relevant screen room door 31 in step 7 to allow the container to enter.

The door 31 is shown more clearly in Figs. 4 and 5 and it comprises a door panel 40 connected by a set of eight wheels 41 to a pair of vertically-extending guide rails 42. At each end of the door mechanism there is a drive

shaft 43 which is connected to the relevant end of both guide rails 42 which are driven to rotate by a rod 44. The up/down action of the rod 44 causes the shafts 43 to rotate, thereby moving the guide rails 42 in and out with respect to the screen room wall. When the shafts 43 rotate in the anti-clockwise direction as viewed in Fig. 5, they move the guide rails 42 outwardly and this action pulls the door panel 40 outwardly by virtue of the door panel being connected to the guide rails by the eight wheels 41. There is an extensive RF sealing arrangement extending around the door panel 40 to provide comprehensive sealing of the door panels 40 to the wall of the screen room 30. Once the door panel 40 has been moved outwardly away from the screen room wall, an hydraulic ram 45 is operated to slide the door panel 40 upwardly on the guide rails 42 to provide an opening in the screen room. Before this action is commenced, the controller ensures that no other screen room door is being opened at the same time to prevent interference between the rooms.

The drawing of Fig. 5 shows the external in-feed and return transverse conveyors 34 and 35 respectively. These conveyors stop short of the door 31 and just inside the door within the screen room 30, there is a corresponding pair of corresponding internal in-feed and return conveyors 46 and 47 respectively. These conveyors communicate with one or more testing stations at which a test operator carries out various tests on the units. These tests are generally of a functional nature as they involve use of the receivers and/or transmitters within the screen room to provide transmission and reception tests. In addition, the operator may tune components of the circuit and make any other necessary adjustments such as potentiometer settings. All of these tests and adjustments may be made in the safe knowledge that there is no interference caused by testing of other units.

Similar operations may be carried out on five other different models within the other screen rooms 30. When the testing of each unit is complete, the operator applies the top part of the moulded plastics casing to complete the assembly of the radio unit and the units are then stacked into the same container and placed on the return conveyor 47. When the container is full, the return conveyor 47 is operated to convey the container to the door mechanism 31. The production controller will then direct opening of the door provided no other door is being opened at that particular time and the internal conveyor 47 and the external conveyor 35 are then operated to convey the container 21 in such a manner as to bridge the gap between the two conveyors after the door panel 40 has been moved out of position. As indicated by step 10 of Fig. 1, an additional operation performed by the test operator is to input various test data into an interface of the production controller for automatic recordal of this data with correlation to the container code and also to the model number.

Once outside of the screen room, the container is moved onto the return longitudinal conveyor 36 which moves the container to a final test workstation. This is a single workstation where a relatively quick final test is carried out to verify the type of casing and the manner in which it is packaged, and also to carry out a far-field range test on the radio communication aspects of the circuit. This test is carried by use of a receiver located at approximately 50 metres from the workstation, which receiver provides a return signal indicating safe reception of a signal from the unit being tested. Radio signals transmitted and received by such radio units have different effects based on electromagnetic and induction effects depending on the distance between the receiver and transmitter. Induction effects are important for near-

field situations whereas electromagnetic effects are important for far-field situations. Thus, testing of the units is extremely comprehensive, while at the same time being efficient. Because the final tests are carried out in sequence and on the combined output of all of the screen rooms 30, the question of interference does not arise.

The latter steps are indicated by the numeral 11 in Fig. 1 and in step 12 the container of units which have received the final test are conveyed to a packing station illustrated by Figs. 7 to 10. Fig. 6 shows the manner in which a radio unit 50 is packed. As shown in the drawing there is a lower plastics blister 51 in which there is a compartment 52 for reception of the unit 50. The compartment 52 has a pair of grooves 53 which is provided to accommodate grooves or projections in the front face 50 of the radio unit 50. These grooves are on each side of the control buttons are keys for the radio unit and help to prevent activation of the keys while the units are packed. The blister 51 also includes a separate compartment 54 for ancillary devices such as a chain and a bead so that the unit may be attached easily to a key ring or other device by the end user. Finally, there is a backing card 55 having a cut-out 56 to allow easy reading of a label 57 which is adhered to the rear surface of the radio unit 50.

Packing of the radio unit in this manner is achieved by initially stacking a large number of the blisters 51 in a set of ten hoppers 62 shown in Fig. 7. A support plate 60 having a set of ten apertures 61 for reception of blisters 51 is shown in detail in Fig. 8 and this is mounted beneath the hoppers 62 for reception of the blisters 51. The plate 60 is automatically moved into registry with various further workstations for packing of the units. As

shown in Fig. 9, there is a reel 65 having a chain which is dispensed into a cutting mechanism 66 communicating with a dispenser 67 for dropping cut lengths of chain into funnels or tubes 68, one associated with each of the blisters 51 on the plate 60. Thus, there is automatic dispensing of a pre-set length of chain into the compartment 54 of each blister 51. At the next station, shown in Fig. 10, vibratory hoppers 70 feed small beads via ten tubes 71 to the compartments 54 of the blisters 51 mounted in the plate 60. After this operation, the plate 60 is conveyed to a sealing station where the backing card 55 is sealed to the blister 51 to complete packing of the set of 10 radio units.

It will be appreciated that at all stages of transporting the units from one place to another there is automatic recognition of the container code and this provides the production controller with an indication at all times of the location of the container and this code is of course correlated with the model number and the quantity to provide an accurate status of the production process at all times. There is very efficient testing and this is carried out in an extremely comprehensive manner with both near-field and far-field tests being carried out. This helps to ensure quality of the radio unit product while at the same time efficiency is not sacrificed.

The invention is not limited to the embodiments hereinbefore described, but may be varied in construction and detail.

CLAIMS

1. A final production and testing method for hand-held radio units, the method comprising the steps of :-

separating radio unit circuits from assembled and soldered circuit panels;

placing each individual circuit in a bottom casing half and stacking partially-assembled units in a conveyor container and subsequently placing a lid over the container, the lid have a code affixed thereto;

conveying the container to an inspection station at which the bar code is automatically detected and the detected codes being automatically uploaded to a production controller of a model code, the production controller automatically correlating the container code with the model code;

the production controller automatically identifying a relevant screen room to be used for testing the units within the container according to pre-stored RF isolation plans;

conveying the container by use of longitudinal and transverse in-feed conveyors to the selected screen room, the production controller directing opening of a door adjacent the transverse in-feed conveyor, the production controller operating the transverse in-feed conveyor and also an internal conveyor within the screen room to convey the container across a gap between the transverse and

internal conveyors so that it is conveyed to a testing station within the screen room;

at said testing station, carrying out RF transmission and reception tests and circuit adjustments and subsequently completing assembly of the radio unit by applying the remainder of the casing and any other units such as model labels;

the production controller directing conveying of units on return conveyors out of the screen room and to a final inspection station at which each unit is sequentially inspected; and

conveying the finally inspected units to a packing station at which automatic blister packing takes place so that the unit front is visible through a transparent blister, said blister having projections corresponding to grooves on the unit front casing half adjacent to the switches to provide protection for the switches when the units are stacked.

2. A method as claimed in claim 1, wherein far-field range test is carried out at the final inspection station in communication with a receiver and a transmitter located at least 50 metres away.

3. A method as claimed in any preceding claim, wherein the lid of the container is transparent and includes a permanently-affixed label having a bar code, said bar code being automatically identified by overhead bar code scanners mounted at different stages of the conveyors.

4. A method as claimed in any preceding claim, wherein the door of the screen room is opened by an initial outward movement of a door panel, followed by a sliding movement of the door panel away from the door opening.

5. A method as claimed in claim 4 wherein the door panel is pulled outwardly by engagement of a set of wheels on a rail which is driven to move outwardly, the door panel subsequently sliding on said rail to provide the opening.

6. A method as claimed in any preceding claim, wherein the controller controls the doors so that only one door of all of the screen rooms is open at any one time.

7. A method as claimed in any preceding claim, wherein packing is carried out by mounting a plurality of blisters within a support plate having corresponding apertures for reception of the blisters and moving said plate to a series of workstations at which the apertures are in registry with dispensing devices.

8. A method as claimed in claim 7, wherein the step of packing involves sub-steps of automatically cutting lengths of chain and dispensing individual lengths of chain into tubes for delivery of the chain lengths to particular compartments within the blisters mounted in the plate.

9. A method as claimed in claim 8, wherein the packing machine includes a vibratory feeder for supply of small components to individual compartments within blisters mounted in the plate.

10. A method substantially as hereinbefore described, with reference to and as illustrated in the accompanying drawings.

11. Radio units whenever produced by a method as claimed in any preceding claim.

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Patents Act 1977 Examiner's report to the Comptroller under Section 17 (The Search report)	Application number GB 9416508.1
Relevant Technical Fields (i) UK Cl (Ed.M) B8A AB, AEE (ii) Int Cl (Ed.5) B65G 49/00, 43/00, 43/08	Search Examiner MR S WALLER Date of completion of Search 8 NOVEMBER 1994
Databases (see below) (i) UK Patent Office collections of GB, EP, WO and US patent specifications. (ii) ONLINE DATABASES: WPI	Documents considered relevant following a search in respect of Claims :- 1-11

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Category	Identity of document and relevant passages	Relevant to claim(s)
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